

# **Electrochemical Quartz Crystal Microbalance Study of Corrosion of Phases in AA2024-T3**

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The corrosion behavior of Cu-containing Al alloys is controlled by the electrochemical activity of the inter-metallic compounds (IMC's). Some of the particles, such as Al<sub>2</sub>Cu and Al-Cu-Fe-Mn phases are typically cathodic to the matrix, while others, such as Al<sub>2</sub>CuMg or S phase, have been considered to be anodic. However, the as-polished surface of S phase particles usually is noble to the matrix, and they can become noble as a result of dealloying of Mg and Al, which results in Cu enrichment. The fluctuation of nobility with time makes it extremely difficult to track the corrosion process. This is further complicated by cathodic corrosion associated with the alkalinity generated at local cathodes. This non-steady-state interaction between the different particles and between the particles and matrix is a critical part of the corrosion process.

In this work, electrochemical quartz crystal microbalance (EQCM) was used to investigate the effect of a number of parameters on the activity of Cu-rich IMC's and matrix in Al alloys. EQCM has advantages over the conventional electrochemical methods due to its high sensitivity to mass changes at the electrode surface and in situ capability. The possibility of recording simultaneously the mass changes of the metal electrode and the corresponding potential and net current has led to a number of applications of the EQCM technique. However, EQCM has only recently been applied to the study of corrosion and corrosion inhibition.

A disadvantage of EQCM is that it requires samples to be in the form of thin films deposited onto quartz. Therefore, thin film analogs of Al alloy matrix and various IMC's were tested. Such analogs can have similar compositions as the bulk phases, but the structure might be different. In this work, the thin film analogs were fabricated by the flash evaporation technique. The thin film samples were potentiostatically polarized at different potentials and in different solutions. The corresponding current and mass changes were measured by the EQCM technique.

One application of this approach is for the study of cathodic corrosion. The current measured by a potentiostat is the net current, a sum of the cathodic and anodic reactions. The EQCM allows direct determination of the anodic reaction rate from the rate of mass change, and the cathodic reaction rate can be calculated from the difference between the measured net current and the anodic rate. The proportion of anodic dissolution under cathodic polarization conditions depends on the applied potential, the bulk solution and the electrode material.